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A Regional Computable General Equilibrium Model for Guatemala

Modeling Exogenous Shocks and Policy Alternatives

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ABSTRACT

In this paper we develop a dynamic regional computable general equilibrium (CGE) model for Guatemala that incorporates regional disaggregated sectors for agriculture. The model is designed to be useful as a development tool for determining the effects of regional investments intended to reduce regional poverty and also to explore policy options to deal with a number of macro and balance-of-payments issues. Our model extends previous modeling work on Guatemala in several ways. First, it develops an updated regional social accounting matrix (SAM) for 2008, coupled with an updated CGE. Second, the CGE is a recursive dynamic model that incorporates unemployment in the short run. Most CGE models are not useful for short-run analysis because they are comparative static models that assume full employment. We specify a fixed minimum wage and an informal sector and use a recursive dynamic framework to solve for the short-run adjustment process that occurs as the economy responds to shocks. Second, the model is regional, permitting us to examine the impact of sectoral development policies, particularly those focused on agriculture.

Guatemala has one of the lowest investment rates in Latin America. We show that if the investment share is raised by 4percent over five years, the rate of growth of the economy rises by about .6 percentage points. Guatemala is also quite sensitive to external macro disturbances. Our dynamic model gives a first approximation of the timing and nature of the adjustment over the ten years following various macro disturbances. We show that after ten years most of these shocks are absorbed by changes in the real exchange rate and the composition of output rather than the rate of growth of output. Negative shocks cause a real devaluation and a shift from consumption and non-tradables and towards exports and tradable goods. An important empirical question is whether the adjustment toward the traded goods sector is as flexible as the underlying elasticities in the model imply.

Keywords: General Equilibrium Models, Guatemala, economic development, regional CGE model, macro shocks

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1. INTRODUCTION

In this paper we develop a dynamic regional computable general equilibrium (CGE) model for Guatemala that incorporates regional disaggregated sectors for agriculture. The model is designed to be useful as a development tool for determining the effects of regional investments intended to reduce regional poverty, particularly in the North and West, and also to explore policy options to deal with a number of macro and balance-of-payments issues. Our model extends previous modeling work on Guatemala in several ways. First, it develops an updated regional social accounting matrix (SAM) for 2008, coupled with an updated CGE. Second, the CGE is a recursive dynamic model that incorporates unemployment in the short run. Most CGE models are not useful for short-run analysis because they are comparative, static models that assume full employment. We specify a fixed minimum wage and an informal sector, and we use a recursive dynamic framework to solve for the short-run adjustment process that occurs as the economy responds to shocks. We also use the dynamic model to address a number of growth questions. Finally, the model is regional, permitting us to examine the impact of sectoral development policies, particularly those focused on agriculture.

The paper starts with a brief overview of the macro performance of the country, including some evidence bearing on the factors that can help explain the growth slowdown. In Section 2 we present a short description of the regional CGE model and its key characteristics. In Section 3 we look at the effects of investment on gross domestic product (GDP) and then show the sensitivity of the economy to balance-of-payments shocks, including the impact of several macro shocks that have hit the economy in recent years: first, variations in the inflow of remittances and direct foreign investment; second, a rise in the international price of food; and finally, a rise in the price of oil. In Section 4 we simulate several alternative investment strategies aimed either at expanding exports or at improving the productivity of agriculture, particularly in the poorer areas of the country. Section 5 concludes.

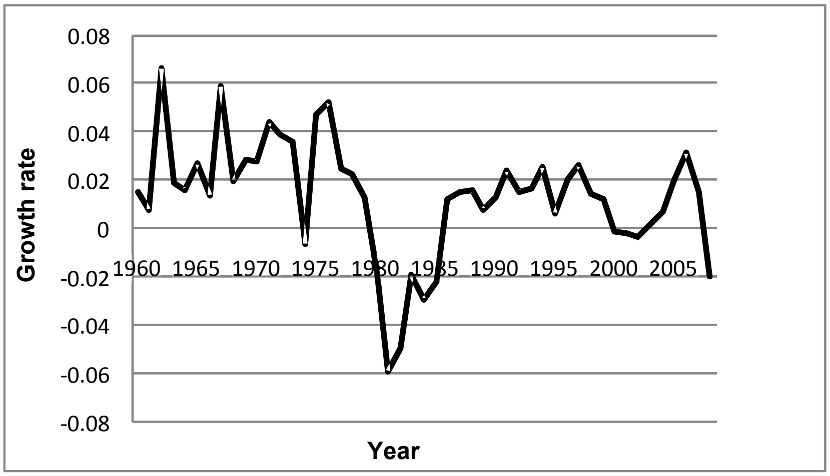
Guatemala's Challenging Macroeconomic Environment

Growth in Guatemala since the turn of the millennium has been lackluster, far worse than what the economy achieved before 1980. Between 1960 and 1981, the average annual growth rate of per capita income was 2.6 percent. Then the country went through two decades of steep recession and civil war, from which it had only partially recovered by the year 2000. From 2006 to 2008, with large inflows of remittances and buoyant export markets, the country finally seemed to have overcome a long 25-year period of stagnation and was growing faster than at any time since the mid-1970s. All this came to a sudden halt due to both the current political crisis and the downturn in the United States, which shrank both remittances and exports. As a result, over the entire 9 years since the turn of the millennium, per capita income has grown by only 0.5 percent per year.

To make matters worse, poverty rates in Guatemala are among the highest in Latin America, and such growth as there has been has not done much to alleviate it. According to the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), in 2006, 55 percent of the entire Guatemalan population had an income of less than the poverty line, a situation only marginally changed over the previous decade. This is not particularly surprising, given the slow growth rate of per capita income. But the picture is particularly serious in the rural sector, where two-thirds of the population is poor, and 42 percent are extremely poor. Because of the relatively low level of urbanization in the country these figures imply that two-thirds of all poor people and three-fourths of extremely poor people live in the countryside. What is as worrisome as this pattern is the fact that since 2002, virtually all the progress in poverty reduction that has occurred has taken place in the urban sector. Rural poverty indexes barely moved between 2002 and 2006. If Guatemala is going to make significant progress in poverty reduction, it will have to raise its overall growth rate and also confront the rural poverty problem. These are the two problems to which this paper is addressed.

Figure 1.1 shows Guatemala's annual growth rate of GDP per capita in a time path between 1960 and 2009. What is quite clear is the deterioration in growth performance since 1980. In the 21 years prior to 1980, there were 7 consecutive years when the average annual growth rate of GDP per capita exceeded 3.5 percent; in only a single year was there negative growth. Since 1980, there have been no comparable periods of rapid sustained growth; moreover, in 10 years the growth was negative.

Figure 1.1—Growth rate of GDP per capita, 1960–2009



Source: Authors' worksheets.

The main points to be drawn from Figure 1.1 are the good performance of the Guatemalan economy from 1960 to 1980, the sharp contraction through 1986, the slow recovery through the 1990s, a new recession from 2001 to 2003, accelerating recovery through 2007, and then a new recession in 2008/09. The economy grew rapidly before 1980, but then stagnated in the 1980s and 1990s. Because of the stop-and-go nature of the recovery after 1986, it took 25 years for Guatemala to surpass the per capita income it had in the peak year, 1980. To show this pattern more formally, we ran two regressions of per capita GDP in constant local currency units on a time trend. The first regression covered the period 1960–1980 and the second, 1980–2009. According to the regressions, the average rate of growth of GDP per capita over the period 1960–1980 was 2.9 percent, one of the highest rates in Latin America. But after 1980, the growth rate slowed to only 0.7 percent. This result leads us to ask two questions. First, what happened after 1980 to the relatively dynamic Guatemalan economy of the 1960s and 1970s? Second, can the economy again reach the growth rate that it produced before the recession of the last two years?

To better understand the change in growth performance after 1980, consider the changes in the composition of GDP as well as the average growth rate of its different components, shown in Table 1.1.

Table 1.1—Growth rates of components of GDP in different time periods

	Average growth rates			Average shares		
	1960-1981	1981-2000	2000-2008	1960-1981	1981-2000	2000-2008
Government	0.0524	0.0387	0.0143	7.23	6.68	8.27
Investment	0.0632	0.0250	0.0731	14.42	14.50	20.50
Exports	0.0635	0.0313	0.0313	18.20	16.99	24.71
Imports	0.0458	0.0394	0.0499	20.43	22.25	39.45
Consumption	0.0485	0.0272	0.0381	80.58	84.08	85.98
GDP	0.0534	0.0258	0.0376	100	100	100

Source: Authors' worksheets.

In the period before 1980, growth was led by exports and investment. Although the country ran a small trade deficit, the rate of growth of exports exceeded that of imports by a comfortable margin. Household consumption grew, but at a slower rate than GDP. This implies that domestic saving financed a significant share of capital formation. The period after 2000 was completely different. Investment still expanded, but the real contrast is in the behavior of exports, imports, and household consumption. Exports were no longer the engine of growth they had been prior to 1980. Household consumption now played that role. Capital formation increased, but to a large extent that was financed by either capital inflows or remittances. The large increase in imports and in the trade deficit starting in the 1990s and accelerating after 2000 reflects trade liberalization after 1990, the rise of consumption, and the increasing role of remittances in the economy.

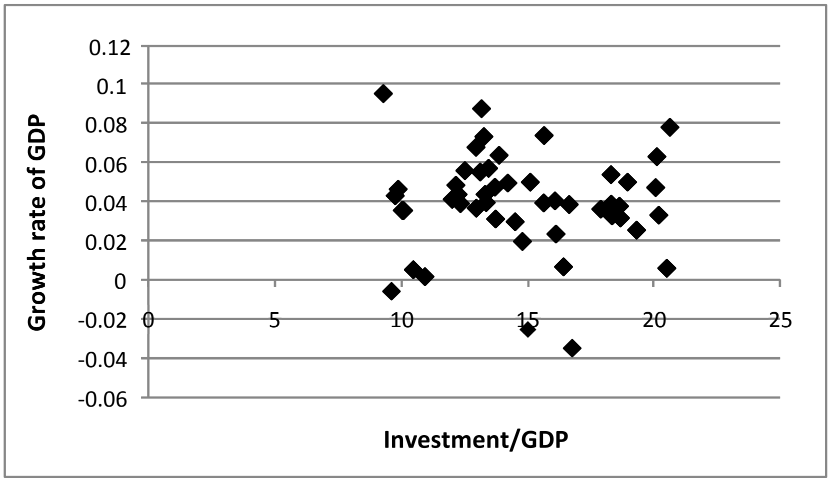
Guatemala is an extremely open economy. When and if the economy grows rapidly, there is also an increase in the demand for imports. Prior to 1980, that required a corresponding increase in exports. That is not the case now. Currently those imports can be financed by remittances. Remittances increase aggregate demand, which generally causes a rise in imports and an appreciation of the exchange rate, which in turn shifts production away from traded goods, such as agriculture and manufactures, and toward nontraded service activities and imports. In the period after 1980, the increased foreign exchange from remittances enabled households to buy more foreign goods without generating as much domestic production or employment as would have been necessary had that consumption been financed by exports. As a result, even though investment increased to the highest shares ever observed in Guatemala, the growth rate of domestic production did not reflect that. We will examine the role of remittances in the growth process using a dynamic CGE model later in the paper.

Investment and Growth

Development economists and supply-side theorists emphasize the importance of fixed capital formation as a driver of economic growth. It contributes in two ways: first by increasing the capital available per worker, thus increasing worker productivity; and second by allowing investment in new, more productive machinery, thus raising total productivity as well. One would therefore expect that increasing the investment share would lead to faster growth rates. Generally economies that do not save and invest do not grow rapidly. But the relationship between investment and growth in Guatemala is ambiguous. Figure 1.2 confirms the positive relationship between investment and growth in the pre-1980 period, but not afterwards. Investment fell in the 1980s, along with GDP, but then it recovered quite strongly after 1990. The investment share in Guatemala averaged more than 20 percent after year 2000, a rate that should have increased the growth rate of the economy. But it did not, at least not until 2006. Generally speaking, it does not look like investment leads to growth in Guatemala.

The investment share is plotted against the growth rate of per capita income in Figure 1.2. Relatively low investment shares in the pre-1980 period were associated with relatively high growth rates, whereas much higher rates of investment in later years were coupled with very low or even negative growth rates in the economy. That is undoubtedly because the debt crisis of those years forced a retraction in demand so that the increases in potential output or capacity made possible by higher levels of investment were not matched by higher levels of demand. But it is somewhat surprising to find that the acceleration of investment after 2000 was not matched by higher growth rates.

Figure 1.2—Investment and growth



Source: Authors' worksheets.

The Shrinking Contribution of Productivity Growth Since 1980

Recent research on economic growth has increasingly focused on the role of knowledge and rising productivity as key determinants of growth. This is not to deny the important roles played by capital and labor, but simply to acknowledge the apparent fact that over long periods of time, for many countries, rising productivity accounts for close to half of observed growth. It is therefore a natural question to ask what role rising productivity has had in the growth in Guatemala and whether it has changed over time. And the clear answer from our research is that there has been a sharp reduction in productivity growth in Guatemala since 1980, similar to that of almost all the countries of the region.[1] For the *lost decade* of the 1980s, that is easy to understand. As previously mentioned, most countries endured painful recessions during that decade, so one would expect that actual output levels would be far below the potential output implied by their capital stocks and labor force. That explanation might even apply to the 1990s, given the very slow recovery that most countries had from the lost decade. But if our research is correct, very low productivity growth rates in Guatemala have continued after the turn of the millennium. That has serious implications for growth.

Here is how we have come to this conclusion. There is no direct way to measure productivity and therefore no way to definitively say what happened to productivity. However, we can use the Solow growth model to get a pretty good first approximation. Assuming a Cobb–Douglas production function, the growth rate of productivity is equal to the difference between the growth rate of GDP and the weighted growth rates of capital and labor, where the weights are equal to the shares of capital and labor in national income.

To make this operational, there are two questions we have to address. Since actual GDP fluctuates, we are going to want to measure the growth rate of GDP between points when GDP is at or near its potential, so the first question is where these points are. For Guatemala, output peaked in 1981, which makes that year the natural endpoint of the period starting in 1960. Output fell during the recession of the early 1980s and then grew, either more or less slowly, until a peak in 2009. Thus our second period should run from 1981 to 2009.

The second question is how to measure the factor growth rates themselves. We can approximate the growth rate of the labor force by using the growth rate of the working-age population. The growth rate of capital is more difficult, simply because national accounts do not contain that information. However,

[1] See Morley (2010) for evidence on other countries in Latin America.

we can use the fact that although we do not know the capital stock, we do know gross fixed investment. Therefore if we go back far enough in the past, and if we can assume a fixed rate of depreciation, we can get a pretty good approximation of what the capital stock must have been at other times, once we set the initial capital stock at some number. It is easy to see that given a long enough time period, the final level of capital will be quite insensitive to the level at which we set the initial capital stock simply because, given enough time, that initial capital stock will have been depreciated away. We are going to start our capital stock–building exercise in 1960, assuming that the capital-to-output ratio was 3 in that year. We also assume a depreciation rate of 5 percent. That will imply that just maintaining the capital stock will require fixed investment equal to 15 percent of GDP. Once we have built up a capital stock using these assumptions, we can then calculate its growth rate between the years when GDP reached an intermediate peak. The growth rate of productivity will then be the observed growth rate of GDP between the peak years, less the growth rate of our estimated capital stock between those same years, less the growth rate of the population, the latter two weighted by the shares of each factor in GDP.[2] The results of all this are displayed in Table 1.2.

Table 1.2—Productivity in Guatemala, 1960–2009

	Growth rates	
	1960-1981	**1981-2009**
Working age population	0.02658	0.02568
Capital stock	0.03451	0.03007
GDP (constant LCU)	0.05338	0.02842
Productivity	2.30%	0.10%

Source: Authors' worksheets.

To summarize all this growth evidence, up to 1980 capacity and actual output grew more or less in tandem. More to the point, good growth rates were achieved with a relatively low rate of investment in the economy, thanks to significant increases in total factor productivity. The situation seems to be completely different after 1980. Guatemala, like all the other countries in the region, had a recession in the early 1980s. Although it subsequently recovered, it reached its potential output level only in 2009. Before 1980 Guatemala got a significant growth boost from productivity. Afterwards, potential output continued to grow, but only because of a large increase in capital formation. In effect, Guatemala was investing more but getting a lot less growth for that effort. Rising remittances and capital inflows assured that there was no balance-of-payments constraint. On the contrary, there was an appreciation of the real exchange rate. None of this produced a return to the growth rates of 1960–1980.

[2] We get the factor shares from our SAM.

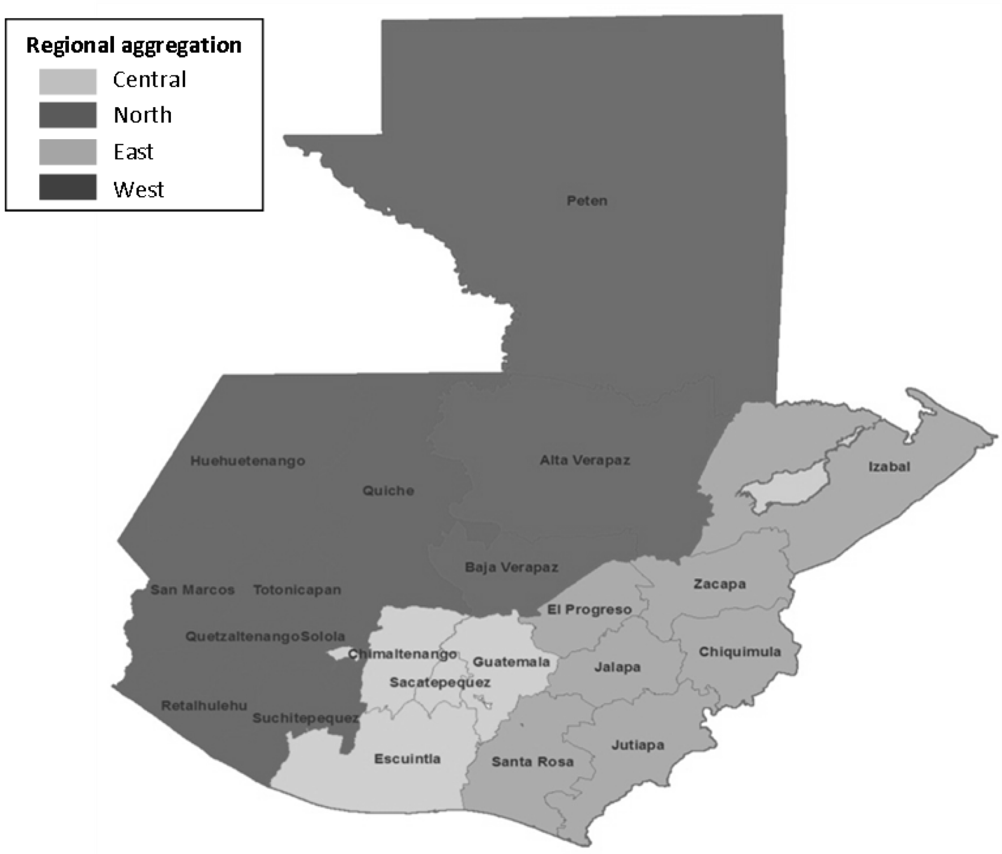
2. THE MODEL

We built a national SAM for 2008, which extended previous work in three directions. First, we regionalized the SAM, using information from a recent agricultural census.[3] Second, we put land into the matrix, which permitted us to tie production in agriculture to each of the four regions in the SAM. Third, we regionalized household income in order to show the regional impact of each of the external shocks or increases in productivity that we simulated.

The SAM is disaggregated into the 61 sectors shown in Table A.1 in the appendix and into the four regions defined in footnote 3. We report data separately for labor by region, divided into skilled and unskilled, formal and informal; for land by region; and for capital. Tab le 2.1 displays the macro SAM that results from aggregating all the columns and rows of the full regionalized SAM.[4]

It is important to note that in the regional SAM for all the agricultural sectors, there are regional activities producing the same commodity. These agricultural activities are disaggregated by the four regions and then combined into one national commodity (Figure 2.1).

Figure 2.1—Regional aggregation for Guatemala



Source: Authors.
Notes: We aggregated the data by department into four regions: North (departments of Baja Verapaz, Alta Verapaz, and Petén), Central (Metropolitana, Sacatepéquez, Chimaltenango, and Escuintla), West (Sololá, Totonicapán, Quetzaltenango, Suchitepéquez, Retalhuleu, San Marcos, Huehuetenango, and Quiché), and East (El Progreso, Izabal, Zacapa, Chiquimula, Santa Rosa, Jalapa, Jutiapa).

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[3] Ministerio de Agricultura, Ganadería y Alimentación. 2011. El agro en cifras, fichas. http://portal.maga.gob.gt/portal/page/portal/uc_upie/fichas.

[4] The full SAM can be requested by email from v.pineiro@cgiar.org.

Table 2.1—2008 Macro SAM for Guatemala, in millions of GTQ (Guatemalan quetzales)

	Activities	Commodities	Transport Costs	Labor	Capital	Land	Households	Government	Import Tax
Activities		470.13							
Commodities	193.02		70.95				259.41	32.23	
Transport Costs		70.95							
Labor	113.83								
Capital	153.47								
Land	8.37								
Households				113.83	153.47	8.37		6.65	
Government									2.41
Import Tax		2.41							
Value Added Tax		19.36							
Direct Tax							11.92		
Subsidies		-1.054							
Activity Tax	1.442								
Change Stocks									
Saving							38.41	-3.93	
Investments									
Rest of World		113.61					11.26	-0.87	

	Value Added Tax	Direct Tax	Subsidies	Activity Tax	Change Stocks	Saving Investment	Rest of World	Total
Activities								470.13
Commodities					-4.53	52.21	72.11	675.41
Transport Costs								70.95
Labor								113.83
Capital								153.47
Land								8.37
Households							38.69	321.00
Government	19.36	11.92	-1.05	1.44				34.08
Import Tax								2.414
Value Added Tax								19.36
Direct Tax								11.92
Subsidies								-1.05
Activity Tax								1.44
Change Stocks						-4.53		-4.53
Saving							13.20	47.68
Investments								
Rest of World								124.00

Source: Authors' worksheets.

Components of the Model

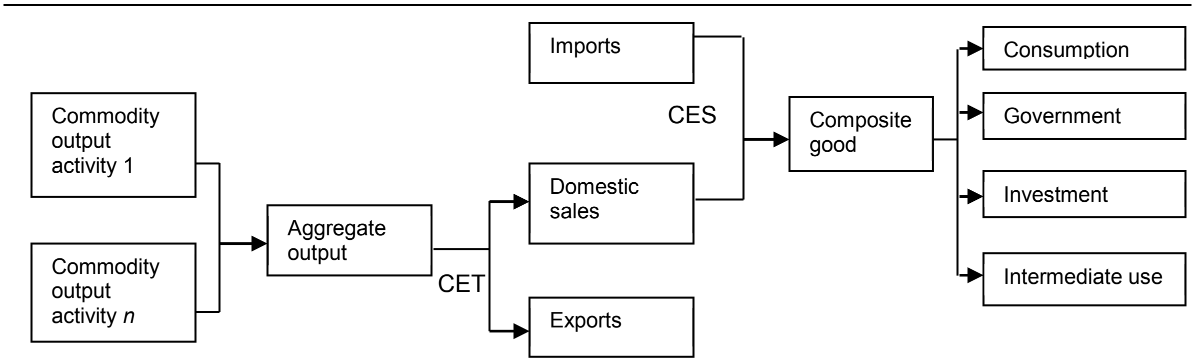
The regional CGE model used in this part of the research is based on the standard model used by the International Food Policy Research Institute (IFPRI) (see Lofgren et al. 2001), which follows the neoclassical–structuralist tradition originally presented by Dervis et al (1982), with some modifications needed to capture the multimarket aspect of the agricultural sector included in this work. The advantage of the regionalized model is that it links decisions made at the national level with outcomes on poverty, employment, and production across regions. That permits us to examine policies intended to improve the regional distribution of activities and income in a consistent general equilibrium fashion, which incorporates national macro fiscal and monetary constraints. This advance is made possible by the availability of regional information from the recent agricultural census.

The CGE model has three components. The first shows the payments that are registered in the SAM, following the same disaggregation of factors, activities, commodities, and institutions shown in the matrix. The second is the equations that represent the behavior of the different institutions present. The third is the constraints that have to be satisfied by the whole system covering the factor and goods markets, the balances for savings and investment, the government, and the current account of the rest of the world.

Each producer maximizes profits under constant returns on scale and perfect competition. There are three factors of production: labor (differentiated by skill and region), land (differentiated by region), and capital. Production is related to factor inputs in a constant elasticity of substitution (CES) production function, which allows producers to substitute these three inputs until they reach the point where the marginal revenue of each factor equals the factor price (wage or rent). The second choice producers make is the amount of intermediate inputs they will use. This specification is made assuming fixed shares that specify the appropriate amount of intermediate inputs per unit of output and of labor or capital (value-added). Finally, output prices depend on the value-added (cost of labor, land and capital), the intermediate inputs, and any relevant taxes and subsidies.

Figure 2.2 shows the flow of a single commodity from producers to final demand. First, there is the combination of goods from all producers into an aggregate commodity output. This is achieved using a CES product demand system with the intention of leaving the option to the buyers as to how much to buy of each individual product (maximizing their consumption). The aggregate output is sold domestically or internationally. The producers' allocation between domestic sales and exports is specified via a constant elasticity of transformation (CET) function, assuming imperfect transformability between exports and domestic sales. The producers will sell their products to the market with the highest profitability. The domestic price is the international price times the exchange rate plus any possible export taxes or export subsidies. The domestic good is combined with imports to produce the composite commodity. For this the Armington (1969) specification is used, which means that the domestically produced and imported goods are imperfect substitutes.

Figure 2.2—Flow of goods from producers to the national composite commodity



Source: Authors.

In this model there are three institutions—households, government, and the rest of the world—which do three things—produce, consume, and accumulate capital. Households save a constant fraction of their disposable income and buy consumption goods with the remainder. Household income is the sum of salaries, profits, and government and rest-of-the-world transfers. Household consumption of goods and services is determined by a linear expenditure system (LES). Government receives taxes, consumes goods and services, and makes transfers to households. The capital account collects the savings from the households, government, and rest of the world, and it and buys capital goods (investment).

As was mentioned in the previous section, our CGE model contains detailed information on the demand and supply of 61 economic sectors and commodities, with 97 correspondent activities (including 12 agricultural activities further disaggregated by 4 regions).

Labor is disaggregated by qualification (skilled and unskilled), by sector (formal and informal), and by region. Workers within each region can migrate between sectors and across regions according to labor demand, but total labor supply grows at a constant rate of 2 percent per year. Land is disaggregated by region and is region-specific. This is one of the elements that drives the regional production results. The other feature of our treatment of labor is the supply curve for unskilled labor in the formal sector. For this factor we assume a fixed minimum wage and assume that there is an excess supply of unskilled labor, at least over the range of solutions that we analyze. Effectively that means that the supply curve of labor is flat, or in other words that the wage is fixed and employment is endogenous. But since the entire model is a real model, or is expressed in terms of the Consumer Price Index (CPI) numeraire, that means that the wage of unskilled labor is fixed in real terms.

Household income and expenditure patterns vary across regions. This is important, since the incomes earned by workers in different sectors will benefit different households, depending on their location and factor endowments. These representative households receive factor incomes and per capita transfers from the national government. Households save some of their incomes and use their remaining income to consume goods under an LES of demand. All commodity markets are national, so prices in all commodity markets differ only in the transportation costs.

The Dynamic Version of the Model

We developed a recursive dynamic CGE model for this study. The model is solved in two stages. The first stage aims to find a solution for a one-year equilibrium using a static CGE model. In the second stage, a model between periods is used to create the dynamic linkages that update the variables that drive growth. The intertemporal equations provide values for all exogenous variables needed for the next period by the static CGE model, which is then solved for a new equilibrium. The model is solved forward in a dynamically recursive fashion, with each static solution depending only on current and past variables. The model does not incorporate future expectations; instead, the behavior of its agents is based on adaptive expectations, since the model is solved one period at a time. The variables and parameters used as linkages between periods are the aggregate capital stock (which is updated endogenously, given previous investment and depreciation), the population, the domestic labor force, factor productivity, export and import prices, export demand, tariff rates, and transfers to and from the rest of the world (all of which are modified exogenously).[5]

The allocation of new capital across sectors is done by adjusting the proportion of each sector's share in aggregate investment as a function of the relative profit rate of each sector compared with the average profit rate of the economy as a whole. Sectors with higher average profit rates will get higher shares of the available investment, and those with lower rates will get lower shares. Over time, sector profit rates should converge.

We assumed that the labor force grows by 2 percent per year, and we add those additional workers to the supply of skilled labor or to the surplus of unskilled labor. The growth of capital is

[5] The dynamic model used in this research follows the models developed by IFPRI (Lofgren, Harris, and Robinson 2001; Thurlow 2004).

determined by the amount of investment, net of depreciation. We also update the rate of disembodied technical change by 1 percent per year, or by a different amount when we do simulated technical change experiments. We can then vary the exogenous rates of savings, taxes, and each of the other policy parameters in the model over time to determine the effects of these changes on the rate of growth of the economy.

As mentioned before, growth in the labor force by skill class is exogenous and related to population growth, which in turn is based on population growth projections taken from national data. For unskilled labor, the total size of the available labor force does not affect the solution in any period because in the simulations we assume that there is an excess or a backlog of unemployed labor, which is not absorbed before the end of our simulations.

The simulations run with the model for Guatemala give us the growth path for the economy for 10 years under a number of different policy alternatives. These paths are compared with the one obtained using the base simulation (in which no exogenous policy changes are included) to see the impacts of implementing various different total factor productivity (TFP) scenarios combined with new investment.

To summarize, the dynamic accumulation process is

1. updated by exogenous trends (labor force growth, productivity changes, capital stock growth, and population growth),
2. updated by economic behavior (distribution of investment by sector, distribution of labor force by sector and category), and
3. updated by implemented policies (changes in remittances, in international prices, and in TFP accompanied with investment).

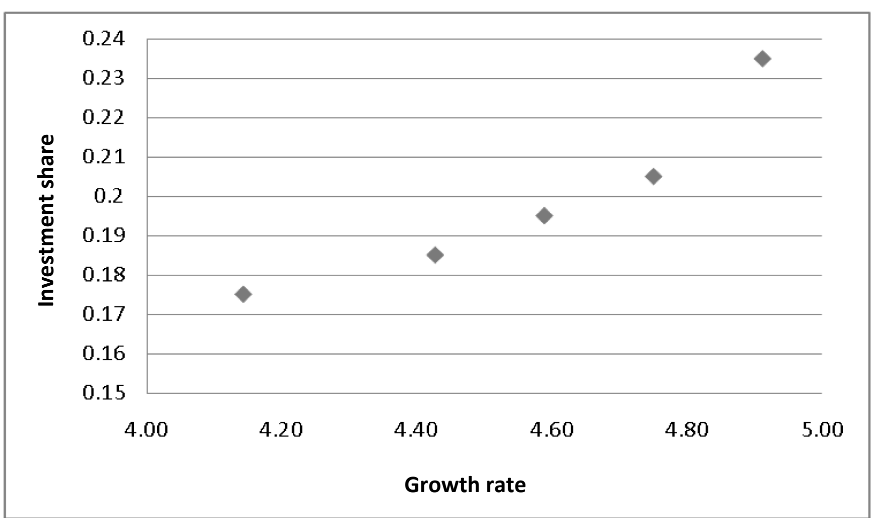
3. THE MACRO SIMULATIONS

The first simulation shows the effect on the growth rate of increasing the rate of capital formation. In the base year, the investment rate is only 18- percent. Given that the capital output ratio is around 3 and the depreciation rate 5 percent per year, this investment rate barely permits any increase in capital intensity. In the base year simulation, we hold the investment share of GDP roughly constant. Given the assumed 1 percent increase in productivity and 2 percent increase in the labor force, the base run gives a GDP growth rate of 4.1 percent per year. Note that this base simulation is somewhat arbitrary because it depends on the capital-to-output ratio that we chose for the model. Since we fix the amount of gross additions to the capital stock in the model, the higher the capital output ratio we choose, the slower the base growth rate will be. For the simulations reported in this paper, we choose a capital output ratio of 4, which gives a base growth rate of 4.1 percent per year. What is critical for the model is that alternative simulations are not particularly sensitive to the capital-to-output ratio we choose. If that is the case, deviations across simulations of the growth rate from the base growth rate will be informative and significant. In other words, what we should and will focus on is changes in growth rates across simulations, not the growth rate itself.

Investment Rate

In our first simulation we ask what happens if Guatemala increases its investment rate. In Figure 3.1 we show how the growth rate of the economy varies with the growth rate of investment. In the base run, the investment share starts at 18 percent and shrinks slightly. That rate produces a growth rate of 4.1 percent per year. If Guatemala is able to raise the growth rate of investment to 5 percent per year, the growth rate of the economy rises to 4.4 percent per year, and by year 10 the investment share rises to 19 percent. If the growth rate of investment rises to 7 percent, the investment share rises to 22 percent by year 10, and the growth rate of the economy rises to 4.75 percent. In other words, the economy gets an increase of two-thirds of a percentage point in its growth rate for each additional 4 percentage points that it devotes to capital formation. If in addition we suppose that the rate of technical change is related to increases in capital, then the growth-enhancing impact of capital formation would be enhanced in roughly the same proportion.

Figure 3.1—Investment share and growth



Source: Authors' worksheets.

Obviously if there is no additional external financing available for such an effort, there is a significant short-run cost to consumption of households and perhaps also of the government. In the base run, consumption rises a bit more slowly than GDP because exports have to grow enough to finance necessary imports. If the investment share increases by 4 percentage points (grows by 7 percent per year), household consumption shrinks in absolute amount by about 1 percent to make room for this additional investment. Government spending is assumed to fall by about 4 percent. But then consumption begins to grow at the faster rate (3.9 percent) made possible by the additional capital. Somewhere between years 6 and 7, consumption along the new, higher growth path overtakes that of the base run. After that, households enjoy both a higher level and a faster growth rate of their consumption. , essentially depicting the tradeoff between consumption now and later. If the country is unable to borrow to finance the increase in investment, then the society sets aside a part of its consumption now in order to have more later.

Table 3.1 gives an idea of how the economy produces the additional investment required to raise the growth rate. It shows the percent changes from the base under our three simulated increases in the investment growth rates. The growth of both GDP and absorption increases, but most of that increase has to go into investment. Consumption has to decline, as we have seen, but in addition there has to be an increase in exports because investment is more import-intensive than is either government or private consumption. Thus if the economy is going to increase capital formation, it will require more complementary imports. But since foreign saving and remittances are both assumed to be constant, which requires additional exports. That in turn requires a real devaluation. As can be seen in the table, in order to raise the investment growth rate to 7 percent, for example, there has to be a real devaluation of almost 3 percent above the base. That real devaluation chokes off some of the imports that would otherwise enter the economy during the rise in investment, and it also is an incentive to increase exports by just enough to keep foreign saving constant.

Table 3.1—Effects of changes in investment on growth rates of macro variables

	Initial	Base	Inv +5%	Inv +6%	Inv +7%	Inv +10%
Absorption	328.74	3.55	3.80	3.94	4.08	4.23
Consumption	256.49	3.57	3.84	3.80	3.75	3.68
Investment	49.99	3.20	5.00	6.00	7.00	8.00
Stocks	-4.56					
Government	26.83	3.47	0.00	0.00	0.00	0.00
Exports	71.22	5.62	6.34	6.64	6.94	7.25
Imports	-124.97	3.49	3.98	4.18	4.39	4.61
GDP at market prices	274.99	4.14	4.43	4.59	4.75	4.91
Real exchange rate	100.00	6.10	7.50	8.20	8.80	9.50

Source: Authors' worksheets.

Macro Shocks

We now look at three one-time macro shocks to an exogenous variable—first a fall in remittances, second a rise in the international price of food, and third a rise in the price of imported oil—tracing the first 10 period reactions to the shock. We consider first the impact of a change in remittances (see Table 3.2). Remittances are a crucial component for all the Central American economies. In the base scenario for Guatemala, they make up 12 percent of household income and are half the size of total exports. They are far larger than net foreign saving since a larger part of them goes to finance household consumption than is used for investment. In the simulations reported here, we assume that the change in remittances represents at the same time an equivalent change in the supply of foreign saving. Lowering remittances by

10 percent reduces the supply of U.S. dollars both to households and to foreign exchange markets by the same absolute amount. Table 3.2 shows how various changes in remittances affect the economy. The table shows the effects of the changes in the inflow of remittances on the 10-year growth rates in our dynamic simulation. In column 1 we reduce remittances by 10 percent, in column 2 we raise them by 10 percent, and in column 3 we raise them by 20 percent.

Table 3.2—Growth rates of macro variables with different remittance levels

		Base	-10%	+10%	+20%
Real	Absorption	3.55	3.22	3.87	4.18
	Consumption	3.57	3.24	3.89	4.20
	Investment	3.20	2.85	3.54	3.87
	Government consumption	3.47	3.22	3.70	3.92
	Exports	5.62	6.03	5.20	4.79
	Imports	3.49	3.17	3.82	4.14
	GDP at market prices	4.14	4.03	4.25	4.36
Prices	Real exchange rate	6.10	8.10	4.20	2.30
	Nominal exchange rate	5.00	6.70	3.40	1.80

Source: Authors' worksheets.

Remittances have a powerful effect on both the overall growth rate of the economy and its composition, especially the latter. When there is a reduction in the supply of remittances, the real exchange rate depreciates and the growth rate of GDP declines, but by less than the decline in consumption, investment, or absorption. These three all fall by around .3 percent, compared with .1 percent for the GDP growth rate. The reason is that the reduction in foreign saving from a smaller inflow of remittances has to be made up by either more exports or fewer imports. As a result, when remittances decline the export growth rate increases and the import growth rate declines, all of which at least partially offsets the reduction in foreign exchange.

Consider now the sectoral impact of changes in remittances. To make the patterns easier to see, in Table 3.3 we aggregate the information into four broad sectors. We find, as expected, that rising remittances are negatively related to both agricultural and manufacturing exports and positively related to imports in those same two sectors. But that is not true for total output. As the table demonstrates, both agricultural and manufactured output rise with remittances despite the fact that exports from the two sectors go down and imports go up at the same time. That is because the rise in remittances allows such a large rise in household consumption that this more than offsets the small reduction in exports and the rise in imports. In other words, while raising the inflow of remittances hurts producers as exporters, they come out ahead as producers thanks to the big rise in domestic demand.

Table 3.3—Change over 10 years in value-added, exports, and imports

	Agricultural	Manufacture	Construction	Services
	Value Added			
Base	10.88	31.65	5.63	64.81
Remit-10	10.65	32.03	5.06	62.23
Remit+10	11.09	31.30	6.20	67.34
Remit+20	11.28	30.97	6.76	69.81
	Exports			
Base	3.64	30.64	0.23	10.75
Remit-10	4.04	33.36	0.26	11.78
Remit+10	3.23	28.03	0.21	9.74
Remit+20	2.81	25.51	0.18	8.78
	Imports			
Base	1.58	37.10	0.00	1.34
Remit-10	1.40	33.53	-0.01	0.94
Remit+10	1.77	40.76	0.01	1.77
Remit+20	1.96	44.50	0.02	2.23

Source: Authors' worksheets.

Remittances clearly have a large impact on trade and the structure of production. They permit the substitution of imports for the domestic production of tradables, and they reduce the need to produce foreign exchange by exporting. Thus, when we reduce remittances by 10 percent, exports of manufactures rise, imports fall, and manufactured value-added rises slightly. At the same time, value-added falls in the two main nontraded goods sectors, construction and services.[6] Agriculture is a mixed sector because it depends heavily on imported inputs, particularly fuel and fertilizer. So while the rise in the real exchange rate in response to a reduction in remittances helps exporters as sellers, it hurts them as buyers of necessary inputs. The same phenomenon applies to manufacturing. The real exchange rate is a double-edged sword. Real devaluation helps all producers of tradables as sellers, but at the same time it raises their costs. This dependence on imported intermediate inputs, particularly of petroleum, makes output in Guatemala quite insensitive to even fairly large changes in the real exchange rate.

In the next set of simulations we first raise prices of Guatemala's traditional exports—coffee, bananas, and cardamom—as well as sugar and grain, and then raise the price of imported oil. Not surprisingly, on balance the food price shocks are positive for Guatemala and the oil price shock is negative. They have similar and offsetting effects on the terms of trade, but the magnitude of their effects on exports, real exchange rate, production, and absorption are quite different. Consider first the food price shock, shown in Table 3.4. Raising food prices by 30 percent improves the terms of trade by 4 percent and permits an increase in absorption, investment, and consumption. There is also an appreciation of the exchange rate, a fall in total export growth, and a rise in imports. What is surprising is that this favorable terms-of-trade effect has very little effect on the growth rate of GDP. The reason is that since the economy can produce the same level of welfare (absorption) with less production, it does so. It imports more, exports less, and raises consumption, investment, and absorption, all with about the same level of GDP.

[6] A rise in remittances has exactly the opposite effects.

Table 3.4—Effect of raising the price of food (percent change)

		Base	Food Price +10%	Food Price +20%	Food Price +30%
		Percentage change per year from initial value			
Real	Absorption	3.55	3.57	3.60	3.64
	Consumption	3.57	3.58	3.60	3.63
	Investment	3.20	3.26	3.33	3.40
	Government cons.	3.47	3.53	3.59	3.65
	Exports	5.62	5.56	5.50	5.42
	Imports	3.49	3.51	3.53	3.57
	GDP at market prices	4.14	4.15	4.15	4.16
		Percentage Change from Initial Value			
Prices	Real exchange rate	6.10	6.10	6.10	6.10
	Nominal exchange rate	5.00	4.00	3.00	2.00
	World export prices		1.40	2.90	4.30
	World import prices		0.50	0.90	1.40
	World price index		0.80	1.70	2.50
	Domestic price index	-1.00	-1.20	-1.40	-1.50
	Terms of trade		1.00	1.90	2.90

Source: Authors' worksheets.

A one-time rise in the price of oil, on the other hand, hurts everyone, as shown in Table 3.5. It forces a large real exchange devaluation and a decline in the rate of growth of both production and absorption. The rate of growth of consumption, investment, and government expenditures all fall. Since foreign saving is held constant in this experiment, exports have to rise and non-oil imports have to fall by enough to pay for the higher-priced oil. In the formal sector, where unskilled labor is assumed to have a fixed wage, unemployment rises relative to both the base run and to the initial amount. For the other factors, all of which are assumed to have flexible wages, wages or rates of return fall, with the negative impact particularly severe for land.

Table 3.5—Effect of raising the price of oil (percent change)

		Base	Oil price +10%	Oil price +20%	Oil price +30%
		Percentage change per year from initial value			
Real	Absorption	3.55	3.42	3.31	3.22
	Consumption	3.57	3.43	3.31	3.20
	Investment	3.20	3.16	3.12	3.11
	Government cons.	3.47	3.33	3.19	3.05
	Exports	5.62	5.76	5.87	5.97
	Imports	3.49	3.33	3.21	3.12
	GDP at market prices	4.14	4.10	4.07	4.03

Table 3.5—Continued

		Base	Oil price +10%	Oil price +20%	Oil price +30%
		Percentage change from initial value			
Prices	Real exchange rate	6.10	9.00	11.80	14.50
	Nominal exchange rate	5.00	4.60	4.10	3.50
	World export prices		1.50	3.10	4.60
	World import prices		3.20	6.50	9.70
	World price index		2.60	5.20	7.90
	Domestic price index	-1.00	-1.50	-2.00	-2.50
	Terms of trade		-1.60	-3.20	-4.60

Source: Authors' worksheets.

It is worthwhile to think for a minute about how the Guatemalan economy adjusts to this unfavorable change in conditions. Partly it is done through a nominal devaluation and a rise in international prices. But that is not particularly helpful to exporters because Guatemala does not produce or export oil and because the devaluation increases their costs. That being the case, what causes exports to go up? The answer has to be found in factor costs. In Table 3.6 we show the wage rate in year 10 relative to the base run. In the formal sector the real wage of unskilled labor is fixed at the minimum wage. But wages for all other factors have to fall by enough to clear each factor market. As can be seen, the rental rate for land and the wages of informal-sector labor, both skilled and unskilled, decline. Skilled formal-sector labor and capital suffer a much smaller impact. These declines in factor returns permit a reduction in the prices of almost all produced commodities except those most directly affected by the cost of fuel inputs, with the result that the relative price and profitability of exports goes up. It is worth emphasizing that this requires a substantial fall in the real wage of all the factors of production other than formal-sector unskilled labor—particularly those linked to agriculture. For formal-sector unskilled labor, loss of income happens not through falling wages but through rising unemployment, which increases by 30 percent relative to the base by year 10 of the simulation. In the simulation this all happens painlessly. But in the real world, these sorts of changes in factor returns are never painless or easy to achieve. A rise in the price of oil of the magnitude shown here could bring with it significant political costs and unrest.

Table 3.6—Effect of an oil price shock on the growth of factor returns per year

	Base	Oil +10%	Oil +20%	Oil +30%
fcain	1.338	1.14	0.951	0.773
fcafo	1.294	1.246	1.231	1.252
fncin	1.309	1.084	0.861	0.642
fncfo				
fcap	0.574	0.476	0.393	0.325
flnd	4.748	4.466	4.173	3.868

Source: Authors' worksheets.

4. THE REGIONAL MODEL AND SIMULATIONS

There is a large variation across the regions of Guatemala in average levels of income, poverty, and economic structure. For development planning purposes it is useful to have a regionalized version of the national model that will reflect this heterogeneity. With a regional model we can simulate the impact of investment programs targeted to poor regions with unexploited economic potential, high levels of poverty, or both. Unfortunately we do not have sufficient information on regional trade flows to build a fully regionalized model where regional markets clear at different prices with differences between demand and supply satisfied by interregional trade flows. The regional model that we develop here is partial in two dimensions. First, our regionalization of production covers only the agricultural sectors, wherein land is a geographically fixed factor of production. Second, all markets, both agricultural and nonagricultural, are national. Production in all agricultural sectors is regional, but the commodities produced all flow into a national market, where one single commodity price clears the market. Households, household consumption, and household income are distinguished by region, but all purchases are made in national product markets.

We have the same six factors of production that we had in the national model: skilled and unskilled labor in the formal and informal sectors, capital, and land, but in this case we have all categories of labor and land also disaggregated by region. Capital grows or shrinks over time in each sector in response to differences in relative productivity and the overall amount of capital formation in the economy. Each labor factor increases at an exogenous rate in each region. In that sense there is no permanent migration of labor between regions in the model. But since production outside of agriculture is not regionally defined, laborers who live in one region may in fact work in another region. Therefore even though there is a regional wage for each type of labor, each of these labor markets clears at a wage that will be very close to equal across regions, and we will treat income earned as if it came from the region of residence rather than the region where the production takes place. But what about formal-sector unskilled labor, for which we impose a fixed minimum wage? Here we have no market-clearing wage mechanism and therefore no way for unemployment rates to be equal across the country. As we will see, exogenous changes in conditions have different effects on unemployment and therefore on regional incomes across the country.

The Regional Breakdown and Distribution of Arable Land between Crops

For this exercise, we divided the country into four regions, North, Central, East, and West (shown in Figure 2.1). We then allocated the total amount of arable land across the sectors included in our CGE model using data from the *fichas* Ministry of Agriculture (2008). Table 4.1 shows the resulting distribution of land across crops and regions. Table 4.2 shows yields by crop, in both tons and US dollars.[7]

[7] All dollar amounts are in US dollars.

Table 4.1—Arable land by crop and region, in hectares

Sector	West	North	East	Central	Total
Traditional	262,543	200,954	150,349	137,116	750,963
Cereal	146,560	353,837	40,895	34,279	575,571
Beans	68,765	115,538	36,084	14,691	235,079
Potatoes	150,177	14,442	10,825	14,691	190,136
Vegetables	107,269	28,885	12,028	144,462	292,644
Fruit	45,973	57,769	39,692	24,485	167,919
Oilseeds	64,362	0	1,203	2,449	68,013
Flowers	12,259	0	1,203	14,691	28,153
Sugar	15,324	0	1,203	73,455	89,982
Other	27,584	14,442	1,203	2,449	45,677
Total	900,817	787,106	294,685	462,768	2,445,376

Source: Authors' worksheets.

What is particularly important to us in Table 4.2 is the striking differences in gross receipts per hectare for different crops. Fruits and vegetables have the highest gross receipts, followed by the traditional export crops of bananas, sugar, and coffee, as well as potatoes. The subsistence crops, maize and beans, generate less than one-tenth as much revenue per hectare. Even accounting for differences in the cost of production, it is almost certainly the case that fruits, vegetables, and the traditional export crops generate far more net income per hectare than maize and beans. Regional Distribution of Rural Poverty.

Table 4.2—Yields and sales per hectare by selected crops

	Yield per ha (tons)	Sales per ha
Bananas	42.2	$3,733.90
Coffee	1.0	$813.80
Sugar	86.0	$2,793.90
Tomatoes	34.9	$8,255.80
Avocados	10.2	$6,674.80
Melons	23.1	$4,178.40
Maize	2.3	$77.60
Beans	0.8	$181.70
Potatoes	25.8	$3,723.90

Source: FAOSTAT. (2011).
Notes: Data are for 2008, yield per hectare is in tons, and sales in dollars.

What is particularly important to us in Table 4.2 is the striking differences in gross receipts per hectare for different crops. Fruits and vegetables have the highest gross receipts, followed by the traditional export crops of bananas, sugar, and coffee, as well as potatoes. The subsistence crops, maize and beans, generate less than one-tenth as much revenue per hectare. Even accounting for differences in the cost of production, it is almost certainly the case that fruits, vegetables, and the traditional export

crops generate far more net income per hectare than maize and beans. Regional Distribution of Rural Poverty

One of the main purposes of this paper is to design regional policies that will reduce rural poverty. To do that, we need to get an estimate of where the rural poor are to be found. We have data by municipality for total poverty but no data that distinguish rural from urban poverty at the local level, since all local poverty estimates are based on economy wide poverty lines. Since we are especially interested in rural poverty, we made an approximation to reflect the higher incidence of poverty in the countryside. To do this, we used the rural and urban poverty rates at the national level for 2001/02 reported by ECLAC in its annual publication, Social Panorama of Latin America. According to ECLAC (2002) the poverty rates for the urban and rural sectors in Guatemala were 45.3 percent and 68.0 percent, respectively, in 2001/02. We used this relationship of 0.666 between urban and rural poverty to solve for the rural and urban poverty rates for each municipality, based on the observed overall poverty rate and the observed shares of urban and rural population in each municipality. The resulting rural and urban poverty rates for 2001/02 should be regarded as nothing more than a good guess of the actual rates and used with caution while we wait for better and more up-to-date data.

The Secretaría de Planificación y Programación de la Presidencia (SEGEPLAN) dataset and our adjustments for rural and urban poverty produced an estimate of the incidence of poverty in rural and urban populations at the district level based on data from the 2002 census and the Encuesta Nacional de Condiciones de Vida (ENCOVI) survey in 2002. We aggregated these into our four regions of Guatemala, and they are displayed in Table 4.3. The incidence of poverty tells what proportion of the rural and urban population has a monthly income below the poverty line. It should be noted that since ECLAC used separate poverty lines for the rural and urban populations in calculating the proportion of the respective populations that were poor, in effect we are not using the national line of $546 per year but rather two separate lines whose weighted average would come out to that amount. According to the table, in 2002 about 75 percent of the rural population, or 4.5 million people, were poor. That is to say, they had per capita incomes of less than, and in most cases far less than, $1.50 per day. Poverty incidence, as one would expect, is much less severe among the urban population, but even so some 1.6 million urban inhabitants were below the urban poverty line.[8] Of particular relevance to us here is the concentration of poverty in the rural population and in the four regions in the table. Of the 6 million poor people in the country, three-fourths were in the rural sector, two-thirds of them in the North and West.

Table 4.3—Rural and urban poverty in Guatemala in 2002

	Individuals in poverty		
	Rural	**Urban**	**Total**
North	868,304	171,301	1,039,605
Central	477,591	493,782	971,373
West	2,317,514	681,540	2,999,054
East	862,497	230,231	1,092,728
Total	4,525,906	1,576,854	6,102,760

Source: Authors' worksheets.

[8] The ECLAC poverty lines of $84 per month in the urban sector and $56 in the rural are much higher than the $46 per month used by SEGEPLAN. This must be the main reason why the incidence of urban poverty in the ECLAC study is so much higher than the 30 percent rate implied in Table 4.3.

Looking back at the distribution of arable land by crop and region in Table 4.1, we see that in the two poorest regions of Guatemala, a lot of arable land is devoted to maize and beans, the two crops with the lowest sales per hectare. Very little or no land is devoted to fruits and vegetables, two of the highest-yielding crops. Our simulations are going to show alternative ways of inducing a switch of land from low- to high-profit crops. Our regional CGE model allows us to simulate various ways to do this.

Inducing a Switch to Higher-Profit Crops

The North and the West between them have about 1.7 million hectares of arable land. One-third of that is currently being used to grow maize and another 10 percent is devoted to beans. Yet we know that the gross sales per hectare are at least 10 times higher in fruits and vegetables than they are in these two subsistence crops. We do not know exactly what holds farmers back from making the switch to fruits, vegetables, or flowers, but we are going to assume here that with sufficient investments in infrastructure and extension it would be possible to induce a significant shift in favor of these higher-yielding activities, all or most of which will be assumed to be grown for export—meaning, they are of export quality. To get some idea of the orders of magnitude involved, suppose that the farmers in the North and West are able to shift 100,000 hectares into fruits, vegetables, and flowers, and out of maize and beans. That implies a roughly 14 percent decline in the amount of land used for maize and beans in the North and West. We know the average yield per hectare of maize and beans is about $100 (FAOSTAT, 2011). In contrast, as we showed in Table 4.2, tomatoes generate $8,200 per hectare, avocadoes $6,700, and melons about $4,200. Let us assume that the switchover yields an increase in sales of $4,000 per hectare. Multiplied by 100,000 hectares, this is an additional $400 million per year. The gross sales value of Guatemala's 20 largest crops (excluding animal products) was $2.1 billion. Thus this switch would increase the value of crop sales by about 20 percent. If the entire addition to sales were exported, it would raise exports by about 4.5 percent (their level in 2008 was $ 9.6 billion).

What might it cost to induce such a switch? In 2008, gross capital formation was around $7 billion per year. If we use the same investment growth rate of 7 percent per year that was assumed earlier in the paper, investment doubles over 10 years. Suppose $4 billion of that, or $400 million per year, is devoted to the transformation of agriculture in the North and West. Over time, as the switch is made, if our estimates are accurate, then that additional investment will generate an additional $400 million in sales. In our model, as we will see, that won't happen right away because of the small size of these three exporting sectors in the North and West.

To roughly capture the policy intervention we are discussing, we made four simulations, the results of which are shown in Table 4.4. First, we repeat the base run and a run with investment growing by 7 percent but without any investment-induced changes in the growth rate of productivity. This run is exactly the same one we did in the investment growth simulation discussed in the previous section. The second simulation uses the same overall growth rate of investment but assumes that it all goes to the North and West, where we suppose that the productivity of all crops rises by 10 percent rather than the 1 percent assumed in the base run. The third simulation raises productivity in the North and West by 10 percent, but only in the subsectors of fruits, vegetables, and flowers. In the final simulation we continue to invest in productivity increases in these three export sectors in the North and West, and in addition we give all exporters of these three sectors for all regions an export subsidy of 10 percent.

Table 4.4—Growth rates per year of macro variables in response to regional investment simulations

	Initial	Base	Sim 1	Sim 2	Sim 3	Sim 4
Absorption	328.74	3.55	4.08	4.47	4.16	4.16
Consumption	256.49	3.57	3.75	4.26	3.85	3.84
Investment	49.99	3.20	7.00	7.00	7.00	7.00
Stocks	-4.56					
Government	26.83	3.47	0.00	0.00	0.00	0.00
Exports	71.22	5.62	6.94	7.57	7.09	7.12
Imports	-124.97	3.49	4.39	4.83	4.50	4.52
GDP at market prices	274.99	4.14	4.75	5.19	4.84	4.83
Real exchange rate	100.00	6.10	8.80	7.60	8.90	8.60

Source: Authors' worksheets.
Notes: Simulation 1 = raise growth rate of investment to 7 percent per year. Simulation 2 = simulation 1 + increase of 10 percent in the productivity of all agricultural sectors in North and West. Simulation 3 = simulation 1 + productivity increase in only fruits, vegetables, and flowers in North and West. Simulation 4 = simulation 3 + plus export subsidies to all producers of fruits, vegetables, and flowers in all regions. All growth rates are over a 10-year simulation except for the real exchange rate, which is the percent change relative to the base.

As we have seen, raising the investment growth rate has a substantial effect on the overall growth rate of the economy, even if it does not increase the growth rate of productivity. Raising the investment share from 18 percent to 22 percent increases the growth rate of GDP by 0.6 percentage point. If the economy has more fixed capital it can grow significantly faster, even without considering any link between capital formation and productivity. This can be seen clearly in the comparison of any of the simulations with simulation 1, since each of the others represents a particular way of targeting investment so as to increase productivity. One can think of simulation 2 as regional targeting. Here we might assume that the additional investment improves the transportation network or provides electricity to underserved areas. If such regional productivity gains are achievable, the simulation shows how large an effect they could have on national production. GDP, consumption, and exports would all grow about 0.5 percentage point faster than in simulation 1, where the added investment is assumed to have no effect on productivity. If the productivity stimulus is limited to only the three export sectors in the North and West (simulation 3), the growth impetus is of course smaller. But even so, the growth rate of the economy rises by 0.7 percentage point per year relative to the base run and 0.1 percentage point relative to simulation 1.

An interesting feature of Table 4.4 is the response of exports and the real exchange rate to these simulations. With no increase in productivity and with constant foreign saving, the real exchange rate has to depreciate by 8.8 percent in order to induce the growth in exports necessary to offset import growth. If the investment leads to an increase in productivity, as in simulation 2, the real depreciation is lower and the rate of growth of exports is higher.

Finally, compare simulations 3 and 4. In the latter, we have brought export subsidies into the picture. Productivity increases are assumed in the three export sectors in the North and West, but the subsidies help exporters of those crops in all four regions. What we find is that while these subsidies do increase the growth rate of exports, they also lead to a slight reduction in the growth rate of GDP. That is because the subsidies induce a shift of land out of competing crops and into fruits, vegetables, and flowers. Exports do grow faster, but the opportunity cost of production forgone in the other agricultural sectors appears to completely offset the gains in these three sectors.

We next consider the effects of these various simulations on the agricultural sectors in all regions of the country, as shown in Table 4.5. The simulations are the same as those described in Table 4.4. First, compare simulations 1 and 2, which show the very large kick obtained if investment increases productivity in all sectors of the North and West. In fact, the response is so great from these two regions that there is some reduction in production in the Central and East. Our simulations may be too optimistic on the increases in productivity that are possible, but the message is clear that given enough time, if an effective regional investment strategy can be devised it will have a large and favorable impact on regional production in the two poorest regions in the country, doubling or more than doubling the growth rates of all crops, particularly the high-value crops of coffee, bananas, sugar, fruits, vegetables, and flowers.

If the increases in productivity are confined to fruits, vegetables, and flowers, there is an even larger impact on the growth rate of these three sectors in the North and West. But since total land is fixed, this growth comes at the expense of the other crops, in particular beans, cereals (maize), potatoes, and the traditional export crops of coffee, bananas, and sugar. That did not happen in simulation 2 because those other sectors were assumed to have the same increase in productivity as the three nontraditional export sectors.

Table 4.5—Growth over 10 years in value-added by agricultural sector

Activity		North	South	East	West
traditional exports	base	1.29	1.28	1.29	1.31
traditional exports	sim1	1.32	1.31	1.33	1.35
traditional exports	sim2	4.02	1.62	1.59	3.94
traditional exports	sim3	1.23	1.33	1.32	1.23
traditional exports	sim4	1.16	1.24	1.26	1.15
Activity		**North**	**South**	**East**	**West**
cereals	sim1	1.27	1.26	1.29	1.31
cereals	sim2	2.24	0.81	0.78	2.12
cereals	sim3	1.22	1.37	1.36	1.22
cereals	sim4	1.20	1.32	1.36	1.19
beans	base	1.31	1.31	1.33	1.33
beans	sim1	1.30	1.29	1.31	1.32
beans	sim2	2.40	0.89	0.86	2.31
beans	sim3	1.26	1.35	1.35	1.26
beans	sim4	1.25	1.32	1.35	1.24
potatoes	base	1.26	1.26	1.29	1.31
potatoes	sim1	1.23	1.22	1.26	1.28
potatoes	sim2	1.96	0.70	0.67	1.86
potatoes	sim3	1.21	1.35	1.36	1.23
potatoes	sim4	1.21	1.31	1.37	1.21
vegetable	base	1.34	1.33	1.35	1.25
vegetable	sim1	1.34	1.33	1.35	1.21
vegetable	sim2	3.13	1.20	1.18	2.80
vegetable	sim3	3.53	1.15	1.15	3.41
vegetable	sim4	3.83	1.25	1.29	3.82
fruits	base	1.19	1.19	1.21	1.22
fruits	sim1	1.16	1.15	1.17	1.19
fruits	sim2	3.16	1.13	1.10	3.04
fruits	sim3	3.92	1.11	1.10	3.91
fruits	sim4	4.57	1.24	1.28	4.51

Table 4.5—Continued

Activity		North	South	East	West
flowers	base	1.21	1.21	1.23	1.23
flowers	sim1	1.19	1.18	1.20	1.21
flowers	sim2	4.66	1.66	1.64	4.53
flowers	sim3	5.61	1.72	1.72	5.60
flowers	sim4	6.96	2.07	2.11	6.90
sugar	base	1.44	1.43	1.45	1.45
sugar	sim1	1.49	1.48	1.50	1.51
sugar	sim2	3.49	1.27	1.27	3.42
sugar	sim3	1.45	1.50	1.51	1.44
sugar	sim4	1.46	1.50	1.53	1.45

Source: Authors' worksheets.
Notes: Simulation 1 = Raise growth rate of investment to 7 percent per year. Simulation 2 = simulation 1 + increase of 10 percent in the productivity of all agricultural sectors in North and West. Simulation 3 = simulation 1 + productivity increase in only fruits, vegetables, and flowers in North and West. Simulation 4 = simulation 3 + plus export subsidies to all producers of fruits, vegetables, and flowers in all regions. All growth rates are over a 10-year simulation except for the real exchange rate, which is the percent change relative to the base.

Table 4.6 shows the impact these four simulations on agricultural exports from the main exporting sectors. To get a better understanding of relative size, the numbers in the table are the absolute changes in each export commodity over the 10 years. Not surprisingly, in the base run, even after 10 years the traditional export commodities, bananas and coffee, contribute half the increase in export value. Of particular interest to us here is the impact of productivity increases in just fruits, flowers, and vegetables compared with an across-the-board improvement in regional productivity in the North and West. To see that, compare simulation 2 with simulation 1 or 3. In simulation 1, all we have is an increase in capital. There is no change in the growth rate of productivity. There is a small net effect on traditional exports but none in the other three commodities. However, an across-the-board increase in regional productivity (simulation 2) is a different story. It has a powerful effect on all the commodities, but particularly the traditional exports, whose growth in absolute terms dominates the other three. That, of course, is because these exports were so much larger than the other three to start with. What that says is that investments in across-the-board improvements in regional productivity are likely to have their biggest impact on the traditional crops, at least in the short run. That will give a quick boost to exports, quicker than an investment strategy targeted just to fruits, vegetables, and flowers. One can see that in simulation 3. The growth of traditional exports in this scenario actually falls below that of the base run as land is switched over to the favored sectors. Whereas three-fourths of total export growth in this group came from bananas and coffee in simulation 2, in simulation 3 even though the total increase in exports is cut in half, three-fourths of that growth comes from the nontraditional crops.

Table 4.6—Change in agricultural exports by sector

	Traditional	Fruit	Vegetables	Flowers
base	2.09	0.07	1.40	0.50
sim1	2.42	0.02	1.39	0.49
sim2	11.74	0.87	2.62	1.12
sim3	2.02	1.29	3.09	1.31
sim4	1.41	1.87	3.73	1.64

Source: Authors' worksheets.

Next we consider the effects of these four different development interventions on factor returns. Table 4.7 shows the returns for all factors in year 10 relative to the base year. Except for unskilled labor in the formal sector, whose wage is assumed to be fixed in real terms at the starting minimum wage, the other three factors all have significant increases of roughly 18 percent over 10 years, or 1.7 percent per year. For formal-sector unskilled labor, the gain will be in employment rather than wages, as we will see further on.

Table 4.7—Real wages in year 10 relative to base year

	Base	Sim1	Sim2	Sim3	Sim 4
fcain-n	1.182	1.331	1.403	1.350	1.346
fcain-s	1.184	1.330	1.385	1.347	1.344
fcain-e	1.181	1.329	1.392	1.346	1.341
fcain-w	1.183	1.330	1.403	1.350	1.346
fcafo-n	1.175	1.130	1.170	1.143	1.140
fcafo-s	1.175	1.128	1.165	1.140	1.137
fcafo-e	1.174	1.128	1.165	1.140	1.137
fcafo-w	1.176	1.138	1.179	1.151	1.148
fncin-n	1.175	1.350	1.432	1.381	1.384
fncn-s	1.185	1.359	1.384	1.370	1.380
fncn-e	1.172	1.343	1.374	1.356	1.361
fncn-w	1.179	1.353	1.458	1.391	1.399
fncfo-n	1.000	1.000	1.000	1.000	1.000
fncfo-s	1.000	1.000	1.000	1.000	1.000
fncfo-e	1.000	1.000	1.000	1.000	1.000
fncfo-w	1.000	1.000	1.000	1.000	1.000
fcap	0.999	0.950	1.001	0.961	0.960
fland-n	1.560	1.636	2.474	1.804	1.885
fland-s	1.559	1.652	1.534	1.586	1.709
fland-e	1.528	1.616	1.599	1.608	1.654
fland-w	1.505	1.579	2.595	1.799	1.903

Source: Authors' worksheets.

We have assumed that there is a one national market for capital. Therefore the rate of return, whatever it is, will be the same across regions; in other words, there need be only one row in the table. But in addition, we see that if we increase the supply of capital without affecting productivity, the rate of return falls. If we confine the productivity increase to only the nontraditional exports, we also reduce the profit rate relative to its initial level. It is only when we have a regional investment strategy that succeeds in increasing the productivity of all sectors in the North and West that the profit rate recovers its initial value. Because land is a regionally fixed factor growing at an exogenously fixed rate of 1 percent per year, the model predicts that even in the base run, the rate of return will rise by a bit more than 50 percent over 10 years. That gain rises to around 60 percent if the country manages to increase its growth rate by increasing the rate of growth of capital formation as in simulation 1. If the country targets its investment to the North and West, as in simulation 2, rents in the North and West jump by 2.5 times rather than 1.5 times as in the base run. Rents in the other two regions both fall relative to their levels in simulation 1, and they even fall relative to the base run in the Central region. In the North and West there is also a significant gain in simulation 3, in which all of the additional investment goes into the three nontraditional export sectors, although the absolute gain is smaller, since traditional exporting sectors do not enjoy the assumed productivity gain. When we add an export subsidy to the policy mix, as in simulation 4, rents rise in all regions, particularly in the Central region, where a good deal of the traditional export crops are grown.

Another place where we can see the effects of regionally targeted investment is in the labor share. Just as land in the North and West gains from productivity gains induced by regional or sectoral investment, so does labor. Not surprisingly, the most powerful push comes from the across-the-board regional productivity growth in simulation 2. All labor groups gain in all regions, but the gain is particularly pronounced for labor in the informal sector. There, both skilled and unskilled labor have their wages rising by 40–45 percent over 10 years, compared with around 33 percent in simulation 1 or 18 percent in the base run. Note also that for unskilled labor in the formal sector, the gains come in employment (not shown in the table) rather than in wages, which are assumed constant in real terms. In the North and West, employment growth in simulation 2 is around 27 percent over 10 years, compared with around 17 percent in the base run. But it is also clear from Table 4.7 that the workers in the other two regions gain almost as much as the workers in the North and West because they also gain from increases to capital even though their productivity does not increase. So one could draw a more optimistic message from these simulations, and that is that everyone gains from increases in investment. If these increases are regionally targeted, then the less-favored regions close the income gap slightly as well.

5. CONCLUSIONS

In this study we present a new dynamic regionalized CGE model that we have developed for Guatemala. In its national version the model is a useful tool for analyzing the impact of and the policy response to various macroeconomic shocks. In the paper we used the model to find the effects on the economy of rising oil and food prices and changes in the inflow of remittances. We also simulated how the growth rate of the economy is affected by variations in the rate of growth of investment. In the base run, the economy grows at 4.1 percent per year and invests about 18 percent of GDP, one of the lowest shares of investment in the region. If the investment growth rate rises to 5 percent per year, the GDP growth rate rises to 4.4 percent and the investment share rises to 19 percent. If investment grows by 7 percent per year, the growth rate of GDP rises to 4.75 percent and the investment share rises to 22 percent by year 10. In other words, the economy gets about 0.6 percentage points of additional growth by devoting an additional 4 percent to investment. In the short run, this additional capital formation reduces the growth rate of consumption, but over time both consumption and its rate of growth are higher than in the slow-growth base-run alternative.

By contrast with simpler models, the CGE allows one to see just how the economy responds to exogenous shocks. One of our simulations varies the inflow of remittances from -10 percent to +20 percent. We show that while the rate of growth of the economy is not overly affected by the shock, labor incomes and the composition of output are. When there is a contraction of remittances, there is a significant real depreciation of the exchange rate. Consumption, investment, and absorption all fall as the economy shifts production away from nontradables and toward exports and import substitutes. The model shows quite clearly that because of Guatemala's dependence on imported intermediate inputs, particularly of oil and machinery, it takes quite a large change in the real exchange rate to offset even fairly small fluctuations in remittances.

The same result is seen when there is a negative oil price shock. Since foreign saving is constant, exports have to rise and imports have to decline relative to the base run. It takes a large real devaluation and significant reductions in real wages and employment growth to make that happen, changes that are difficult to achieve in an open political system.

We regionalized the CGE model so that it would be a useful tool for analyzing regional development strategies. Because of our interest in rural poverty reduction and because of regional data limitations, we limited the regional detail to agricultural activities. But that allowed us to simulate various investment strategies targeted to the North and West, the two poorest regions of the country. In our first simulation we set the investment growth rate at 7 percent per year and assumed that enough of it was targeted to the North and West to raise productivity in all agricultural sectors by 10 percent. That in itself raises the growth rate of GDP a full percentage point relative to the base run. Exports rise by 2 percentage points, much of which comes from rising exports of bananas and sugar from the North and West. Labor in every region gains in this simulation, particularly in the informal sector, where wages rise by 40–45 percent over 10 years, compared with 18 percent in the base run. Everyone gains from an increase in investment, even if it is focused on just the poorest regions of the country, provided it produces an increase in productivity. If productivity improvement is limited to just the nontraditional exports in the North and West, the overall gains in growth, consumption, and wages are of course smaller, but they are still considerable.

The regional simulations that we report here are nothing more than a first approximation because we do not know how much it would cost to make the productivity improvements we have assumed. What the simulations make clear, however, is the large impact that can be expected from productivity improvements. An important area for future research is to fill in the gap in our knowledge of what it might cost to make such improvements. The simulations show how important it is to improve our knowledge in this area and to introduce that additional knowledge into the model.

APPENDIX: SUPPLEMENTARY TABLES

Table A.1—Sectors of the disaggregated SAM

Category	Account		Description
Activities/commodities	a-ctrad	c-ctrad	Traditional crops (coffee, banana and cardomo)
	a-cere	c-cere	Cereals
	a-legu	c-legu	Beans
	a-ratu	c-ratu	Roots and tubers
	a-verd	c-verd	Vegetables
	a-frut	c-frut	Fruits
	a-semi	c-semi	Seeds and oil seeds
	a-flor	c-flor	Flowers and plants
	a-espe	c-espe	Spices
	a-taba	c-taba	Tobacco non processed
	a-azuc	c-azuc	Sugar non processed
	a-mveg	c-mveg	Raw vegetable materials
	a-anim	c-anim	Live animals
	a-oanim	c-oanim	Other animal products
	a-silvi	c-silvi	Products of forestry and logging
	a-pesc	c-pesc	Fish and other fishery products
	a-petr	c-petr	Crude oil and natural gas
	a-aren	c-aren	Stone, sand and clay
	a-omin	c-omin	Other minerals
	a-pcarn	c-pcarn	Meat and meat products
	a-ppesc	c-ppesc	Prepared fish
	a-plegu	c-plegu	Prepared vegetables, fruit juices and vegetables
	a-aceite	c-aceite	Oils and animal and vegetable fats
	a-molin	c-molin	Grain mill products
	a-prepan	c-prepan	Preparations used in animal feeds
	a-panad	c-panad	Bakery products
	a-pazuc	c-pazuc	Sugar
	a-pasta	c-pasta	Pasta and other farinaceous products
	a-lacte	c-lacte	Dairy products
	a-opalim	c-opalim	Other food products
	a-bebal	c-bebal	Alcoholic beverages
	a-bebnalc	c-bebnalc	Non alcoholic beverages
	a-ptaba	c-ptaba	Tobacco products
	a-textil	c-textil	Textile fibers, textiles and clothing
	a-cuero	c-cuero	Leather and leather products, footwear
	a-made	c-made	Wood and wood products, except furniture
	a-papel	c-papel	Pulp, paper and paper products, printing
	a-quimi	c-quimi	Productos químicos and refined petroleum
	a-caucho	c-caucho	Rubber and plastic products
	a-onomet	c-onomet	Other non metallic products
	a-metales	c-metales	Base metals
	a-pmetal	c-pmetal	Metal products, machinery and equipment
	a-muebles	c-muebles	Furniture
	a-oprod	c-oprod	Other manufactured goods
	a-eleagu	c-eleagu	Electricity and water
	a-const	c-const	Construction
	a-comer	c-comer	Trade services
	a-aloja	c-aloja	Accommodation, services of providing food and drinks
	a-transp	c-transp	Transportation and storage
	a-select	c-select	Postal services and telecommunications

Table A.1─Continued

Category	Account		Description
	a-spostal	c-spostal	Servicios de intermediación financiera y seguros
	a-sinm	c-sinm	Real state services
	a-salquil	c-salquil	Rental services
	a-gov	c-gov	Public administration and other services to the
	a-sense	c-sense	Education services
	a-ssalud	c-ssalud	Human health services
	a-svet	c-svet	Veterinary services
	a-ssoc	c-ssoc	Social services
	a-salcan	c-salcan	Sewage and refuse disposal, sanitation
	a-oserv	c-oserv	Other social and personal services
	a-sdom	c-sdom	Domestic services
Factors		fcain-n	Labor-skilled-informal-north
		fcain-s	Labor-skilled-informal-south
		fcain-e	Labor-skilled-informal-east
		fcain-w	Labor-skilled-informal-west
		fcafo-n	Labor-skilled-formal-north
		fcafo-s	Labor-skilled-formal-south
		fcafo-e	Labor-unskilled-formal-east
		fcafo-w	Labor-unskilled-formal-west
		fncin-n	Labor-unskilled-informal-north
		fncin-s	Labor-unskilled-informal-south
		fncin-e	Labor-unskilled-informal-east
		fncin-w	Labor-unskilled-informal-west
		fncfo-n	Labor-unskilled-formal-north
		fncfo-s	Labor-unskilled-formal-south
		fncfo-e	Labor-unskilled-formal-east
		fncfo-w	Labor-unskilled-formal-west
		flnd-n	Land-north
		flnd-s	Land-central
		flnd-e	Land-east
		flnd-w	Land-west
		cap	Capital
Households		hhd-n	Households north
		hhd-s	Households central
		hhd-e	Households east
		hhd-w	Households west
Government		gov	Government
Taxes		t-exp	Export taxes
		t-vat	Sales taxes
		t-imp	Import tariffs
		t-com	Commodity taxes
		t-dir	Direct taxes
		t-sub	Subsidies
		t-atax	activity tax
Change in Stocks		dstk	Change in stocks
Savings & investment		s-i	Savings and investment
Rest of world		row	Rest of world

Source: Authors' worksheets.
Note: The first 12 activities (a-chrad – a-mveg) are also disaggregated by region. For instance, there is one activity cereal North, one activity cereal Central, one activity cereal East, and one activity cereal West; they are all combined into one commodity cereal.

Table A.2—Changes in output, exports, and imports by sector in response to changes in remittances, percent change per year

	Output INITIAL	base	oil +10%	oil +20%	oil +30%	Exports INITIAL	base	oil +10%	oil +20%	oil +30%
c-ctrad	1.976	3.683	3.648	3.63	3.63	7.074	1.5	1.617	1.704	1.758
c-cere	7.394	3.984	3.925	3.879	3.848	0.075	0.777	0.779	0.76	0.719
c-legu	2.907	3.796	3.741	3.7	3.676	0.002	13.522	13.851	13.939	13.765
c-ratu	1.928	3.451	3.402	3.368	3.353	0.037	-0.071	-0.088	-0.11	-0.139
c-verd	3.1	3.945	3.893	3.855	3.833	1.091	1.582	1.542	1.489	1.422
c-frut	2.303	3.642	3.588	3.548	3.523	0.38	3.833	3.921	3.928	3.844
c-semi	1.097	4.887	4.824	4.763	4.705	0.141	3.202	3.166	3.104	3.015
c-flor	0.25	3.446	3.407	3.373	3.344	0.416	3.007	2.948	2.866	2.758
c-espe	0.108	4.157	4.134	4.122	4.123	0.007	5.317	5.343	5.303	5.191
c-taba	0.171	5.068	5.004	4.938	4.87	0.243	0.218	0.17	0.087	-0.034
c-azuc	2.365	4.94	4.876	4.812	4.746					
c-mveg	0.358	6.501	6.25	5.929	5.535					
c-anim	7.015	5.078	5.023	4.969	4.919	0.008	8.888	8.946	8.966	8.944
c-oanim	3.08	5.22	5.174	5.135	5.104	0.017	8.978	9.046	9.06	9.012
c-silvi	2.776	4.93	4.873	4.828	4.795	0.671	9.127	9.241	9.304	9.31
c-pesc	0.596	4.957	4.911	4.877	4.857	0.207	7.479	7.519	7.532	7.513
c-petr	0.015	14.878	18.169	21.007	23.543	2.547	6.013	5.95	5.873	5.781
c-aren	1.698	4.8	4.652	4.509	4.373	0.019	11.532	11.915	12.211	12.406
c-omin	0.741	4.913	4.892	4.882	4.886	1.877	6.135	6.118	6.092	6.056
c-pcarn	10.847	4.591	4.522	4.465	4.421	0.16	8.646	8.595	8.442	8.174
c-ppesc	0.513	4.196	4.133	4.091	4.07	0.111	7.342	7.302	7.197	7.02
c-plegu	1.613	4.327	4.262	4.212	4.18	0.555	6.654	6.602	6.504	6.352
c-aceite	4.132	4.63	4.616	4.619	4.642	1.804	6.389	6.334	6.238	6.096
c-molin	9.707	4.763	4.694	4.633	4.583	0.441	6.838	6.77	6.649	6.468
c-prepan	1.779	5.076	5.032	4.991	4.953	0.144	6.906	6.851	6.741	6.57
c-panad	15.029	4.645	4.578	4.521	4.478	0.34	7.684	7.642	7.526	7.329
c-pazuc	3.461	4.798	4.732	4.674	4.628	2.387	6.748	6.702	6.606	6.453
c-pasta	0.998	4.625	4.558	4.502	4.46	0.089	7.45	7.406	7.294	7.107
c-lacte	4.935	4.608	4.542	4.488	4.45	0.048	8.187	8.15	8.023	7.797
c-opalim	6.044	4.509	4.455	4.416	4.395	1.172	6.766	6.714	6.612	6.454

Table A.2—Continued

	Output INITIAL	base	oil +10%	oil +20%	oil +30%	Exports INITIAL	base	oil +10%	oil +20%	oil +30%
c-ptaba	0.509	4.882	4.816	4.762	4.722	0.054	6.748	6.716	6.643	6.524
c-textil	18.11	5.367	5.209	5.033	4.839	9.492	7.793	7.463	7.012	6.431
c-cuero	3.699	4.743	4.634	4.53	4.434	0.243	8.298	8.067	7.722	7.252
c-made	2.326	4.773	4.679	4.582	4.483	0.394	7.633	7.495	7.308	7.066
c-papel	7.086	4.984	4.947	4.916	4.89	1.29	7.334	7.193	7.007	6.769
c-quimi	41.832	4.923	4.729	4.601	4.53	7.098	6.12	8.552	10.724	12.711
c-caucho	7.171	4.828	4.827	4.838	4.862	1.443	7.189	6.334	5.412	4.416
c-onomet	7.284	4.727	4.668	4.62	4.586	0.718	8.221	7.161	6.041	4.859
c-metale	6.715	5.118	5.011	4.892	4.761	1.583	6.379	6.185	5.943	5.647
c-pmetal	33.175	4.351	4.314	4.292	4.288	2.449	6.56	6.357	6.102	5.791
c-mueble	3.689	4.204	4.133	4.077	4.041	0.274	7.634	7.312	6.921	6.453
c-oprod	3.913	4.671	4.589	4.514	4.449	0.608	7.485	7.242	6.929	6.539
c-eleagu	8.432	5.12	5.039	4.96	4.881	0.099	11.503	10.731	9.89	8.973
c-const	38.566	4.19	4.159	4.142	4.141	0.279	6.493	6.442	6.325	6.136
c-comer	80.208	4.883	4.849	4.821	4.801	5.985	8.078	8.172	8.195	8.139
c-aloja	18.153	4.508	4.439	4.379	4.328					
c-sposta	21.441	5.194	5.121	5.053	4.994	0.731	7.57	7.476	7.348	7.181
c-sinter	13.472	5.095	5.064	5.038	5.019	0.077	6.686	6.699	6.69	6.655
c-sinm	30.977	5.663	5.647	5.636	5.629					
c-salqui	23.886	5.034	5.009	4.99	4.978	4.57	8.005	8.058	8.096	8.114
c-sense	10.553	3.852	3.749	3.641	3.525					
c-ssalud	11.682	3.851	3.715	3.575	3.432					
c-svet	0.201	5.149	5.104	5.06	5.016					
c-ssoc	0.254	4.28	4.191	4.106	4.027					
c-salcan	0.053	4.279	4.199	4.122	4.05					
c-oserv	3.807	4.368	4.323	4.284	4.254	0.006	4.819	4.716	4.568	4.371
c-sdom	2.996	4.251	4.172	4.097	4.027					
c-gov	22.415	4.032	3.903	3.772	3.639					

Table A.2─Continued

	Imports INITIAL	Base	Oil +10%	Oil +20%	Oil +30%
c-ctrad	0.012	6.558	6.399	6.287	6.227
c-cere	3.319	5.183	5.113	5.062	5.031
c-legu	0.093	4.92	4.859	4.826	4.825
c-ratu	0.017	5.28	5.215	5.176	5.167
c-verd	0.029	4.895	4.838	4.807	4.804
c-frut	0.419	5.254	5.185	5.144	5.135
c-semi	0.186	6.163	6.093	6.035	5.994
c-flor	0.141	3.597	3.564	3.544	3.536
c-espe	0.039	4.535	4.524	4.533	4.564
c-taba	0.067	7.151	7.083	7.025	6.978
c-azuc					
c-mveg	0.348	6.547	6.293	5.969	5.57
c-anim	0.081	2.616	2.492	2.391	2.316
c-oanim	0.018	3.166	3.064	2.997	2.971
c-silvi	0.099	3.998	3.898	3.808	3.731
c-pesc	0.057	4.053	3.979	3.927	3.899
c-petr					
c-aren	0.17	-0.185	-0.716	-1.176	-1.551
c-omin	0.603	4.807	4.786	4.778	4.786
c-pcarn	0.766	2.541	2.487	2.505	2.605
c-ppesc	0.243	3.46	3.401	3.382	3.409
c-plegu	0.769	3.701	3.637	3.605	3.611
c-aceite	2.864	4.368	4.364	4.385	4.436
c-molin	0.759	3.469	3.408	3.396	3.44
c-prepan	0.305	4.309	4.284	4.289	4.327
c-panad	0.547	3.338	3.281	3.276	3.327
c-pazuc	0.004	3.605	3.538	3.519	3.557
c-pasta	0.066	3.373	3.314	3.306	3.353
c-lacte	1.093	3.432	3.374	3.366	3.415
c-opalim	2.304	3.835	3.788	3.777	3.806
c-bebal	0.404	3.976	3.912	3.878	3.876
c-bebnal	0.347	3.871	3.807	3.773	3.774
c-ptaba	0.085	4.479	4.415	4.379	4.373
c-textil	8.872	4.825	4.73	4.644	4.57
c-cuero	1.054	4.044	4.017	4.028	4.082
c-made	0.4	3.311	3.254	3.217	3.203
c-papel	4.526	4.567	4.557	4.559	4.577
c-quimi	38.298	4.895	4.621	4.418	4.278
c-caucho	4.014	4.362	4.591	4.846	5.13
c-onomet	1.387	3.232	3.761	4.333	4.952
c-metale	6.054	5.082	4.98	4.868	4.745
c-pmetal	28.835	4.242	4.217	4.212	4.228
c-mueble	0.584	2.382	2.481	2.643	2.875

Table A.2─Continued

	Imports INITIAL	Base	Oil +10%	Oil +20%	Oil +30%
c-oprod	2.22	4.282	4.249	4.236	4.246
c-eleagu					
c-const	0.075	1.944	1.933	2.011	2.19
c-comer	2.559	1.955	1.806	1.733	1.744
c-aloja					
c-sposta	0.233	2.919	2.863	2.853	2.896
c-sinter	1.38	3.811	3.744	3.705	3.698
c-sinm					
c-salqui	2.458	2.654	2.568	2.504	2.468
c-sense					
c-ssalud					
c-svet					
c-ssoc					
c-salcan					
c-oserv	0.082	3.938	3.947	4.013	4.142
c-sdom					
c-gov					

Source: Author's worksheets.

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